Space Weather Technical Forecast

Issued on Monday, 06 May 2024 at 13:10 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Further M-flares expected with a chance of isolated X-flares through the period. Geomagnetic activity expected to be unsettled to active with a chance of some G1-G2/Minor-Moderate storm intervals due to CME impacts and a slight chance of isolated G3 conditions. Confidence lower than usual due to limited imagery.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has reached High levels. AR3663 has produced numerous M-flares and 2 X-flares in the last 24 hours, the largest and most recent an X4.5 at 06/0635 UTC and an X1.2 05/1154 UTC. AR3364 also contributed an M2 flare at 05/0938 UTC, and an M1 at 05/1840 UTC. Further M-flares are expected, predominately from either AR3663 or AR3664, with a chance of isolated X-flares.

There are currently nine numbered sunspot regions on the visible disc. The most active remains AR3663, located in the northwest, and which features a large and complex intermediate spot with a delta configuration. However, the intermediate spot looks to be splitting in recent imagery. AR3664 is now the largest spot on the disc and located in the southeast, also with a delta configuration in its southern intermediate spot, where the bulk of the recent areal growth has occurred. AR3668 is just to the east of AR3644 and has increased in size and complexity in recent hours, AR3664 and AR3668 also appear to be magnetically linked. The remaining sunspots on the disc are generally smaller, stable or in slight decay, and magnetically simple.

A CME which originated from AR3663 in association with X4.5 flare at 06/0635 UTC may have an Earth directed component, however updated LASCO/SOHO coronagraph imagery is currently unavailable, and STEREO-A imagery is limited, therefore confidence is much lower than usual.

Solar Wind / Geomagnetic Activity: Solar winds observed by ACE at L1 were initially at background levels, but became slightly enhanced after connection with a HSS after 060600UTC, peaking at around 490 km/s around 061000UTC. Density was initially around average but became above average due to an expected glancing blow from a CME around 052330UTC, peaking at 40ppcc, before falling to average to below average levels for the rest of the period. The Interplanetary Magnetic Field, Bt, was initially weak, but showed a gradual increasing trend to moderate levels, with a peak around 15nT around 06/0000UTC. The north-south component, Bz, was initially weakly positive, then transitioned into a Moderate southward orientation during the UTC evening, peak -12nT, before rotating moderately positive after the CME arrival, then from around 060400UTC it varied with moderate strength. Phi angle was mostly positive (away from the sun) but did have a period of negative (towards the Sun) during the UTC evening. These parameters likely indicating CME influence. Resultant Geomagnetic activity was initially predominantly Quiet (Kp 0-2), becoming Unsettled to Active (Kp 3-4) 05/1800-2359 UTC, with G1 Minor storm (Kp5) from 06/0000-0600, before returning to Quiet. Lerwick observatory recorded a G3/Strong Storm interval (Kp 7) just prior to midnight UTC, likely due to CME impacts.

Energetic Particles / Solar Radiation: High energy proton flux (greater than 10MeV) observed at GOES18 was at normal background levels. High energy electron flux (greater than 2MeV)

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observed at GOES16 remained at largely background levels. The associated 24-hour fluence was well below the Active threshold. Observed fluence at 06/0001UTC was 2.04e6 integrated pfu on a slight upward trend.

Four-Day Space Weather Forecast Summary

Solar Activity: Moderate to High solar activity is forecast to continue with further M-flares expected and a chance of isolated X-flares, principally from AR3663 and AR3664.

Solar Wind / Geomagnetic Activity: There are multiple Earth-directed CMEs currently in the forecast period. A CME associated with 03 May X-flare may interact with Earth on Day 1 (06th May), although this may have been the CME which arrived at 0018UTC earlier today. A CME associated with the 04 May M9 flare may give a glancing blow late Day 1/early Day 2 (6th-7th May). A CME associated with the 06 May X4.5 flare may cause an impact late Day 2/early Day 3 (7th-8th May). Due to lack of imagery there is very low confidence regarding CME arrival times.

Earth is likely under the influence of a HSS from CH35/+ or CH33/+ which is expected to continue through Day 1 and Day 2, before slowly decline through Day 3.

Geomagnetic activity is expected to becoming Unsettled to Active through Day 1, with a chance of some G1- G2/Minor-Moderate storm intervals conditions due to CME impacts and a slight chance of isolated G3/strong storm intervals if CME impact is more significant. Activity should generally subside by 4 (09 May) to mostly Quiet conditions by the end of the period.

Energetic Particles / Solar Radiation: High energy proton flux is most likely to remain at background levels through the period. There is a slight chance for an S1/Minor Storm or greater event throughout however, primarily from AR3663.

High energy electron flux is forecast to be at background to moderate levels throughout, with associated fluence expected to remain well below the Active (1e8 integrated pfu) threshold.

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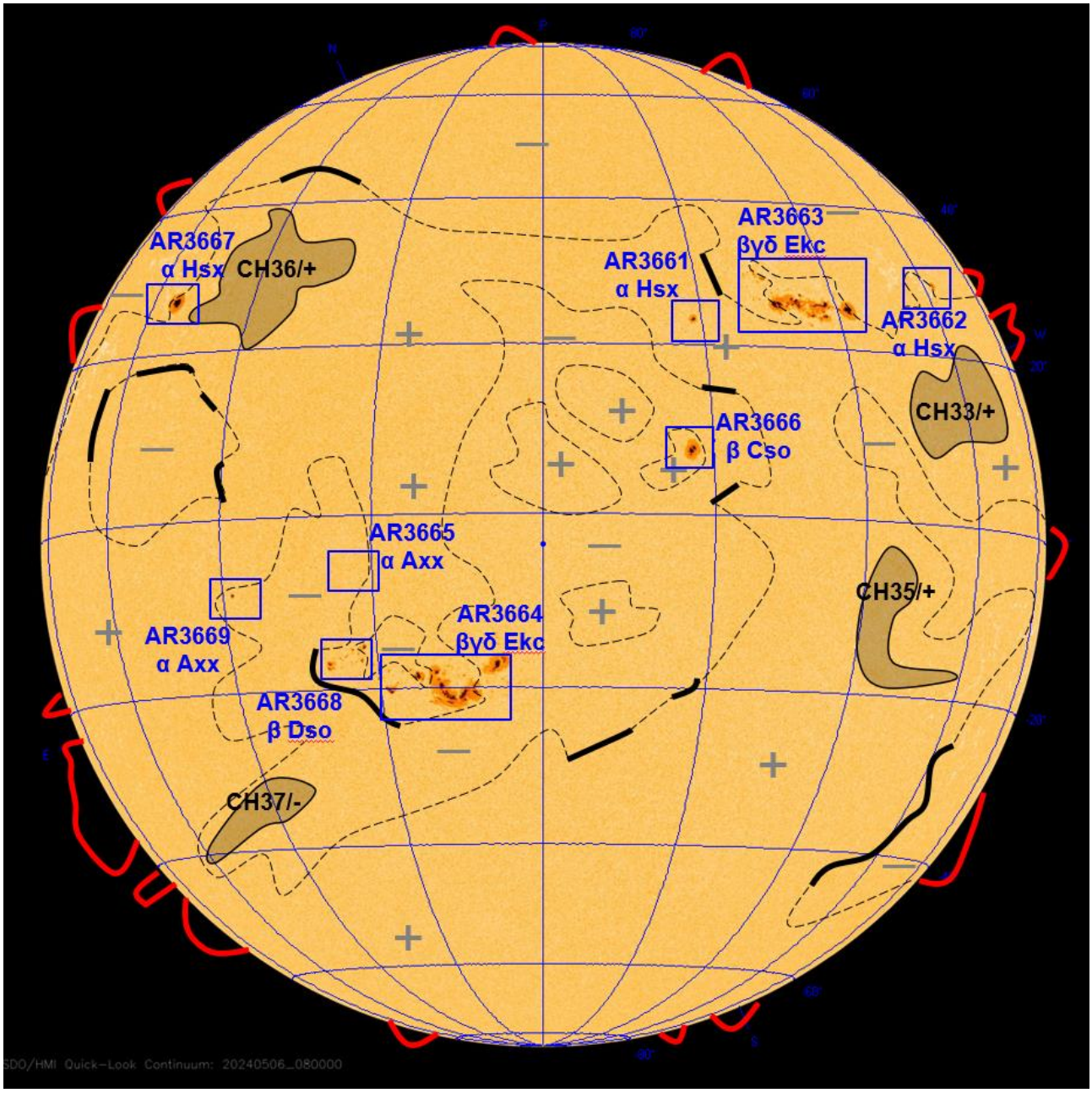
Figure 1. Solar Analysis Valid 06/0800 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Met Office Space Weather Technical Forecast

Geomagnetic Storms:

There are multiple Earth-directed CMEs in the forecast period, although confidence is very low due to an ongoing SOHO imagery gap. A CME associated with the X1.6 flare 03/0222 UTC may interact with Earth during day 1 (06 May), although this may have been the CME which arrived at Earth around 06/0018 UTC. A largely northward directed CME followed the M9 flare on the 4th May, with modelling giving a possible glancing interaction Late Day 1/early Day 2 (6 to 7 May). Another northbound CME in association with the X4.5 flare at 06/0635 UTC has the potential to have earth-directed components and cause an impact late Day 2 (7th May) but more likely early Day 3 (8 May) but again due to lack of imagery this is very low confidence.

The earth is likely connected to a HSS from coronal holes CH33/+ and CH35/+, giving slightly enhanced solar wind speeds. The coronal holes while broadly persistent are noticeably larger than the previous rotation and could see speeds peak at elevated levels between days 1 and 2 (06 and 07 May) before slowly declining, although CME influence may mask the signal.

The combination of coronal holes and potential CME influence through the period, as well as ongoing gaps in imagery, results in a lower than average Geomagnetic forecast confidence throughout.

Geomagnetic activity is expected to increase through day 1 (06 May), becoming Unsettled to Active with a chance of some G1- G2/Minor-Moderate storm intervals conditions due to CME impacts and a slight chance of isolated G3/strong storm intervals if CME impact is more significant. Current thoughts are the CME associated with X4.5 flare on the 06th May is the most likely to cause effects and hence probabilities have been increased slightly Day 3 to represent this. Activity should generally subside by 4 (09 May) to mostly Quiet conditions by the end of the period.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	Yes	50	60	70	20
Strong	G3	No	10	20	20	1
Severe	G4	No	1	1	5	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
03/0646	Partial	AR3663	NE	900 km/s	05/1800 UTC	May have already arrived
04/1125	Partial	AR3663	NE	650 km/s	07/1200 UTC	Glance possible
06/0930	Partial	AR3663	NE	900 km/s	08/1000 UTC	Confidence very low due to imagery outage.

Radio Blackouts - X-Ray Flares:

Solar activity has reached High levels. AR3663 has produced numerous M-flares and 2 X-flares

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in the last 24 hours, the largest and most recent an X4.5 at 06/0635 UTC and an X1.2 05/1154 UTC. AR3364 also contributed an M2 flare at 05/0938 UTC, and an M1 at 05/1840 UTC. Further M-flares are expected, predominately from either AR3663 or AR3664, with a chance of isolated X-flares.

There are currently nine numbered sunspot regions on the visible disc. The most active remains AR3663, located in the northwest, and which features a large and complex intermediate spot with a delta configuration. However, the intermediate spot looks to be splitting in recent imagery. AR3664 is now the largest spot on the disc and located in the southeast, also with a delta configuration in its southern intermediate spot, where the bulk of the recent areal growth has occurred. AR3668 is just to the east of AR3644 and has increased in size and complexity in recent hours, AR3664 and AR3668 also appear to be magnetically linked. The remaining sunspots on the disc are generally smaller, stable or in slight decay, and magnetically simple.

Both AR3663 and AR3664 remain on the visible disk throughout the period, and far-sided helioseismographs indicate a number of returning regions over the northeast horizon in the coming days that may supplement the present risk of significant flares should they persist.

Moderate to High solar activity is therefore forecast to continue pending further developments, with occasional M-flares expected and a chance of isolated X-flares throughout, principally from AR3663 and perhaps to a lesser extent AR3664.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	Yes	90	90	90	90
Very Active	R3 to R5 X Class	Yes	40	40	40	40

Figure 2: Latest GOES16/18 X-ray flux plot.

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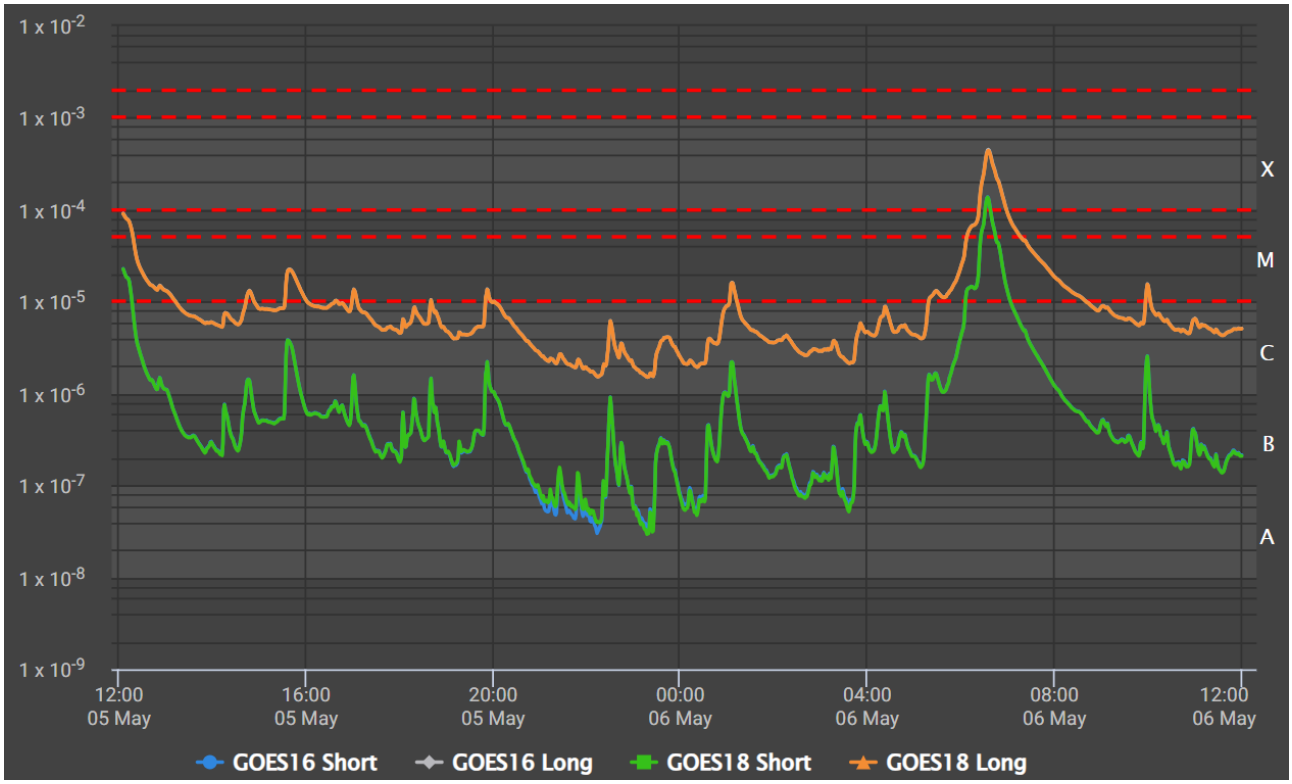

Solar Radiation Storms - (High Energy Protons):

High energy proton flux (greater than 10MeV) observed at GOES-18 has been at background levels and is most likely to remain that way through the period. However, there is a chance of an S1/Minor Storm or greater event occurring throughout, primarily from AR3663 as it transits westward although recent significant flares from this region have so far failed to trigger any significant proton response.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	30	30	30	30
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

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High Energy Electrons Event (≥ 2MeV):

High energy electron flux is at normal background levels. Likely CME and coronal hole influences through the period are expected to limit electron flux at background to moderate levels on all days.

Overall, the 24 hour integrated electron fluence is forecast to remain well below the Active (1e8 integrated pfu) threshold.

GEO Electron Environment	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ 2 MeV ≥ $1x10^{8}$	No	1	1	1	1
Very Active	≥ 2 MeV ≥ $1x10^{9}$	No	1	1	1	1

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